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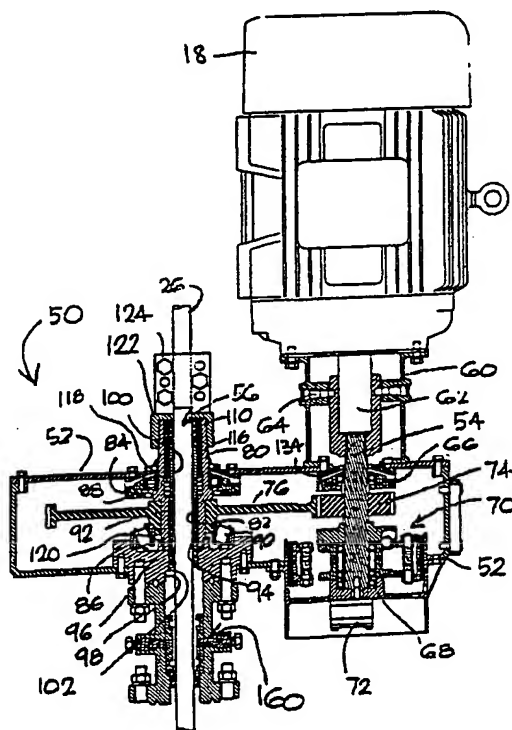
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(54) Titre : TETE DE GROUPE MOTOPOMPE AVEC BOITE A GARNITURE ETANCHE, FREIN CENTRIFUGE ET  
ATTACHE DE VERROUILLAGE POUR TIGE POLIE

(54) Title: PUMP DRIVE HEAD WITH LEAK-FREE STUFFING BOX, CENTRIFUGAL BRAKE AND POLISH ROD  
LOCKING CLAMP



(57) Abrégé/Abstract

A pump drive head for a progressing cavity pump comprises a top mounted stuffing box rotatably disposed around a compliantly mounted standpipe with a self or manually adjusting pressurization system for said stuffing box. To prevent rotary and vertical motion of the polish rod while servicing the stuffing box, a polished rod lock-out clamp is provided with the pump drive head integral with or adjacent to a blow-out-preventer which can be integrated with the pump drive head to save space and cost. A centrifugal backspin braking system located on the input shaft and actuated only in the backspin direction and a gear drive between the input shaft and output shaft are provided.

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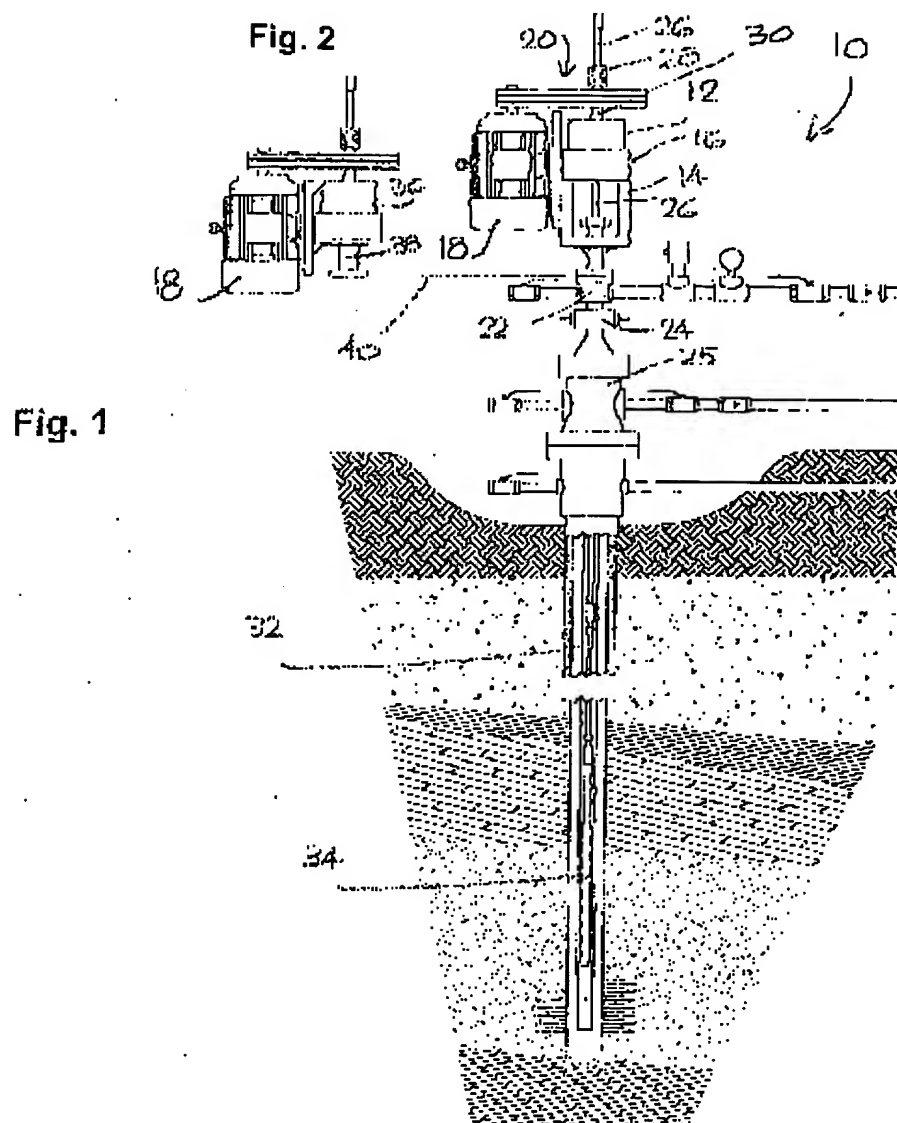
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The present invention relates generally to progressive cavity pump oil well installations and, more specifically, to a drive head for use in progressive cavity pump oil well installations.

## 5 Background of the invention

Progressing cavity pump drives presently on the market have weaknesses with respect to the stuffing box, backspin retarder and the power transmission system. Oil producing companies need a pump drive which requires little or no maintenance, is very safe for operating personnel and minimizes the chances of  
10 product leakage and resultant environmental damage. When maintenance is required on the pump drive, it must be safe and very fast and easy to do.

Due the abrasive sand particles present in crude oil and poor alignment between the wellhead and stuffing box, leakage of crude oil from the stuffing box is common in some applications. This costs oil companies money in service time,  
15 down time and environmental clean up. It is especially a problem in heavy crude oil wells in which the oil is often produced from semi-consolidated sand formations since loose sand is readily transported to the stuffing box by the viscosity of the crude oil. Costs associated with stuffing box failures are one of the highest maintenance costs on many wells.

20 Servicing of stuffing boxes is time consuming and difficult. Existing stuffing boxes are mounted below the drive head. Stuffing boxes are typically separate from the drive and are mounted in a wellhead frame such that they can be serviced from below the drive head without removing it. This necessitates mounting the drive head higher, constrains the design and still means a difficult service job. Drive heads with  
25 integral stuffing boxes mounted on the bottom of the drive head have more recently entered the market. In order to service the stuffing box, the drive must be removed which necessitates using a rig with two winch lines, one to support the drive and the other to hold the polished rod. This is more expensive and makes servicing the stuffing box even more difficult. As a result, these stuffing boxes are typically  
30 exchanged in the field and the original stuffing box is sent back to a service shop for repair—still unsatisfactory.

Due to the energy stored in wind up of the sucker rods used to drive the progressive cavity pump located at the installation and the fluid column on the pump, each time a well shuts down a backspin retarder brake is required to slow the  
35 backspin shaft speed to a safe level and dissipate the energy. Because sheaves



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and belts are used to transmit power from the electric motor to the pump drive head on all existing equipment in the field, there is always the potential for the brake to fail and the sheaves to spin out of control. If sheaves turn fast enough, they will explode due to tensile stresses which result due to centrifugal forces. Exploding sheaves are very dangerous to operating personnel.

### Summary of the Invention

The present invention seeks to address all these issues and combines all functions into a single drive head. The drive head of the present invention eliminates the conventional belts and sheaves that are used on all drives presently on the market, thus eliminating belt tensioning and replacement. Elimination of belts and sheaves removes a significant safety hazard that arises due to the release of energy stored in wind up of rods and the fluid column above the pump.

One aspect of the invention relates to a centrifugal backspin retarder, which controls backspin speed and is located on a drive head input shaft so that it is considerably more effective than a retarder located on the output shaft due to its mechanical advantage and the higher centrifugal forces resulting from higher speeds acting on the centrifugal brake shoes. A ball-type clutch mechanism is employed so that brake components are only driven when the drive is turning in the backspin direction, thus reducing heat buildup due to viscous drag.

Another aspect of the present invention relates to the provision of an integrated rotating stuffing box mounted on the top side of the drive head, which is made possible by a unique standpipe arrangement. This makes the stuffing box easier to service and allows a pressurization system to be used such that any leakage past the rotating seals or the standpipe seals goes down the well bore rather than spilling onto the ground or into a catch tray and then onto the ground when that overflows.

In the present invention, only one winch line is required to support the polished rod because the drive does not have to be removed to service the stuffing box. In order to eliminate the need for a rig entirely, a still further aspect of the present invention provides a special clamp is integrated into the drive head to support the polished rod and prevent rotation while the stuffing box is serviced. Preferably, blow out preventers are integrated into the clamping means and are therefore closed while the stuffing box is serviced, thus preventing any well fluids from escaping while the stuffing box is open.



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### Brief Description of the Drawings

These and other features of the invention will become more apparent from the following description in which reference is made to the appended drawings in which:

- 5     **Figure 1** is a view of a progressive cavity pump oil well installation in an earth formation with a typical drive head, wellhead frame and stuffing box;
- Figure 2** is a view similar to the upper end of **Figure 1** but illustrating a conventional drive head with an integrated stuffing box extending from the bottom end of the drive head;
- 10    **Figure 3** is a cross-sectional view according to a preferred embodiment of the present invention;
- Figure 4** is an enlarged, partially broken cross-sectional view similar to **Figure 3**;
- Figure 5** is a cross-sectional view of a pressure control valve according to a preferred embodiment of the present invention;
- 15    **Figures 6 and 7** are cross-sectional end bottom views, respectively, of one embodiment of a polished rod lock-out clamp according to the present invention;
- Figures 8 and 9** are cross-sectional and bottom views, respectively, of another embodiment of a polished rod lock-out clamp according to the present invention;
- 20    **Figures 10 and 11** are cross-sectional and bottom views, respectively, of a one embodiment of a blow-out preventer having an integrated polished rod lock-out clamp according to the present invention;
- Figure 12** is a cross-sectional view of a centrifugal backspin retarder according to a preferred embodiment of the present invention;
- 25    **Figure 13** is a plan view of the centrifugal backspin retarder shown in **Figure 12**; and
- Figure 14 and 15** are partially broken, cross-sectional views illustrating ball actuating grooves formed in the driving and driven hubs of the centrifugal backspin retarder shown in **Figure 12**.

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### Detailed Description of Preferred Embodiments of the Invention

Figure 1 illustrates a known progressing cavity pump installation 10. The installation includes a typical progressing cavity pump drive head 12, a wellhead frame 14, a stuffing box 16, an electric motor 18, and a belt and sheave drive system 20, all mounted on a flow tee 22. The flow tee is shown with a blow out preventer 24 which is, in turn, mounted on a well head 25. The drive head supports and drives a drive shaft 26, generally known as a "polished rod". The polished rod is supported and rotated by means of a polish rod clamp 28, which engages an output shaft 30 of the drive head by means of milled slots (not shown) in both parts. The well head frame 14 is open sided in order to expose the polished rod 26 to allow a service crew to install a safety clamp on the polished rod and then perform maintenance work on the stuffing box 16. The polished rod drives a drive string 32 which, in turn, drives a progressing cavity pump 34 located at the bottom of the installation.

Figure 2 illustrates a typical progressing cavity pump drive head 36 with an integral stuffing box 38 mounted on the bottom of the drive head and corresponding to that portion of the installation in Figure 1 which is above the dotted and dashed line 40. The main advantage of this type of drive head is that, since the main drive head shaft is already supported with bearings, stuffing box seals can be placed around the main shaft, thus improving alignment and eliminating contact between the stuffing box rotary seals and the polished rod. This style of drive head reduces the height of the installation because there is no wellhead frame and also reduces cost because there is no wellhead frame and there are fewer parts since the stuffing box is integrated with the drive head. The main disadvantage is that the drive head must be removed to do maintenance work on the stuffing box. This necessitates using a service rig with two lifting lines, one to support the polished rod and the other to support the drive head.



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The drive head of the present invention is arranged to be connected directly to and between an electric drive motor and a conventional flow tee of an oil well installation, house drive means for rotatably driving a conventional polished rod and for not only providing the function of stuffing box but one which can be accessed from the top of the drive head to facilitate servicing of the drive head and stuffing box components.

Another aspect of the present invention is the provision of a polished rod lock-out clamp for use in clamping the polished rod during drive head servicing operations. The clamp can be integrated with the drive head or provided as a separate assembly. Finally, the drive head may be provided with a backspin retarder to control backspin of the pump drive string.

Referring to Figures 3 and 4, the drive head according to the preferred embodiment of the present invention is generally designated by reference numeral 50. The drive head includes a housing 52 in which is mounted an input or drive shaft 54 and an output shaft assembly 56 drivingly connected to a conventional polished rod 26. The input shaft is connected directly to an electric drive motor 18, eliminating the conventional drive bells and sheaves and the disadvantages associated therewith. The output shaft assembly 56 provides a fluid seal between the fluid in the drive head and the fluid in the oil well. The fluid pressure on the drive head side of the seal is above that of the oil well. The fluid seal provides the functions of a conventional stuffing box and, accordingly, not only eliminates the need for a separate stuffing box, which further reduces the height of the assembly above the flow tee, the seal is easily serviceable from the top of the drive head, as will be explained.

Electric motor 18 is secured to the drive head by way of a motor mount housing 60 and includes a motor drive shaft 82 which is drivingly connected to input shaft 54 by a releasable coupling 64. Input shaft 54 is rotatably mounted in upper and lower input shaft bearing assemblies 66 and 68, respectively, which are secured to housing 52. The lower end of the input shaft is coupled to a centrifugal backspin retarder 70 and to an oil pump 72. A drive gear 74 is mounted on the drive shaft and meshes with a driven gear 76.

Driven gear 76 is drivingly connected to and mounted on a tubular output shaft 80 which is part of the output shaft assembly 56 and which is formed with an inner bore 82. The output shaft functions as a rotating stuffing box. The output shaft is mounted in upper and lower output shaft bearing cap assemblies 84 and 86,





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respectively, secured to housing 82. Upper bearing cap assembly 84 houses a roller bearing 88 and the lower bearing cap 86 houses a thrust roller bearing 90 which vertically supports and locates the output shaft and driven gear in the housing.

5 A standpipe 92 is concentrically mounted within the inner bore 82 of output shaft 80 in spaced apart relation to define a first axially extending annular fluid passage 94. The lower bearing cap assembly 86 includes a downwardly depending tubular housing portion 96 with a bore 98 which communicates with the bore 100 of the standpipe. The lower end of the standpipe is seated on an annular shoulder defined by a snap ring 102 mounted in a mating groove in inner bore 98 of the lower  
10 bearing cap assembly. The standpipe is prevented from rotating by a pin 104 extending between the lower bearing cap assembly and the standpipe. The upper end of the standpipe is received in a static or ring seal carrier 110 which is mounted in the upper end of the output shaft.

Standpipe 92 is arranged to concentrically receive a conventional polished  
15 rod 26 in annularly spaced relation thereto to define a second axially extending annular fluid passage 114.

A plurality of ring seals or packing 116 are provided at the upper end of first annular fluid passage 94 between the inner bore of the output shaft and the outer surface of the standpipe 92 and between the underside of the seal carrier and a  
20 compression spring 118. A bushing or labyrinth seal 120 is provided between the outer surface of the lower end of the output shaft and an inner bore of the lower bearing cap assembly. The upper end of the second annular passage communicates with the upper surface of the packing. The fluid in the first annular passage and spring 118 act on the lower side of the packing, opposing the pressure  
25 exerted by the well fluid in the second annular passage.

The upper end of the output shaft is threadedly coupled to a drive cap 122 which in turn is coupled to a polished rod drive clamp 124 which engages the polished rod 26. A static seal 126 is mounted in the seal carrier to seal between the  
30 seal carrier and the polished rod.

A pressurization system is provided to pressurize the seal mounted in the tubular drive shaft. To that end, the upper and lower bearing cap assemblies include a diametrically extending oil through passages 130 and 132, respectively. One end of the passage 130 in the lower bearing cap is connected to the high pressure side of the oil pump 72 by a conduit (not shown) and communicates with the lower end of



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the first annular passage 94. The high pressure side of the pump is also connected to a pressure control valve 133 which, if the pressure delivered by the pump a set point of either control valve, the valve will open and allow oil to communicate with passage 132 in the upper bearing cap assembly by a conduit (not shown). The other  
 5 end the through passage 132 in the upper bearing cap assembly communicates with a similar through passage 134 in the upper bearing cap of the drive shaft. The fluid pressure supplied to passage 130 is maintained above the pressure in the well. A pressure differential in the order of 50 to 100 psi is believed to be adequate.

A spool valve 140 is mounted in a port 142 formed in the wall 144 of the  
 10 lower tubular portion of the lower bearing assembly. An access cap 146 is threaded into the outer end of the port. A spring 148 biases the valve outwardly. As best shown in Figures 4 and 5, an axial passage 150 connects the through passage in the lower bearing cap with the port. A second passage 152 connects the port to the upper bearing cap. The inner end of the valve communicates with well pressure.  
 15 The outer end of the valve communicates with pump pressure against the action of the spring. The spool valve serves to maintain the fluid pressure applied to the seals greater than the well pressure.

In operation, when the motor is powered, the motor drives the input shaft which, in turn, drives the drive gear and the driven gear. The driven gear drives the  
 20 tubular shaft, which drives the drive cap and the polished rod. The input shaft also drives the oil pump which applies fluid to the first annular fluid passage at a pressure which is greater than the oil well pressure in the second annular fluid passage. This higher pressure prevents oil well fluids from entering the drive head housing. The spool valve automatically adjusts the fluid supplied to the bearings in response to oil  
 25 well pressure.

A further aspect of the present invention is the provision of a polished rod lock out clamp 160 for use in securing the polished rod when it is desired to service the drive head. The clamp may integrated into the drive head or may be provided as a separate assembly which is secured to and between the drive head and a flow tee.  
 30 Figures 6 - 9 illustrate two embodiments of a lock-out clamp. As shown, in each embodiment, the clamp includes a tubular clamp body 162 having a bore 164 for receiving the polished rod 26 in annularly spaced relation. A bushing 166 is mounted on an annular shoulder 168 formed at the bottom end of the bore 164 for centering the polished rod in the housing. Flanges 166 are formed at the upper and lower



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ends of the housing for bolting or otherwise securing the housing to the underside of the drive head and to the upper end of a flow tee. The clamp includes two or more equally angularly spaced clamp members or shoes 170 about the axis of the housing/polished rod. The clamp shoes are generally in the form of a segment of a cylinder with an arcuate inner surface 172 dimensioned to correspond to the curvature of the surface of the polished rod. Spring means 174 are provided to bias the clamp members to an un-clamping position.

The lock out clamp is provided with shoes which are actuated by radial bolts 176 to clamp the polished rod such that it cannot turn or be displaced radially. This lock out clamp would preferably be located in an extension piece between the flow tee and the bottom of the drive head. Alternately, it can be built into the lower output shaft bearing cap of the drive head.

In a further embodiment of the polished rod lock out clamp, the clamping means is integrated with a blow out preventer 180, shown in Figures 10 and 11. Blow out preventers are required on all oil wells. They traditionally have two opposing radial pistons 182 actuated by bolts 184 to force the pistons together and around the polish rod to effect a seal. The pistons are generally made of elastomer or provided with an elastomeric liner such that when the pistons are forced together by the bolts, a seal is formed between the pistons, between the pistons and the polish rod and between the pistons and the piston bores. Actuation thus serves as a means to prevent well fluids from escaping from the well.

In accordance with the present invention, an improved blow out preventer serves as a lock out clamp for well servicing. In order to serve this purpose, the pistons must have a substantially metal surface which can be forced against the polished rod to prevent motion thereof. The inner end of the pistons is formed with an arcuate recess 186 with curvature corresponding substantially to that of the polished rod. The sealing function of the blow out preventer must still be accomplished. This can be done by providing a narrow elastomeric seal 188 which runs across the horizontal flat face of the piston, along the arcuate recess, along the mid height of the piston and then circumferentially around the piston. This sealing means seals between the pistons, between the pistons and the polish rod and between the pistons and the piston bores. Thus, well fluid is prevented from coming up the well bore and escaping while the well is being serviced, as might be the case while the stuffing box is being repaired.



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Referring to **Figures 12 - 15**, the centrifugal brake assembly **70** is comprised of a driving hub **190** and a driven hub **192**. The driving hub **192** is non-rotatably connected to the input shaft **64**. The driven hub **192** is mounted for rotation on the input shaft by an upper roller bearing **194** and a lower thrust bearing assembly **198**.

5 One end of each of a pair of brake shoes **198** are pivotally connected to the driven hub by pivot pins **200**. A pin **202** on the other end of each of one brake shoe is connected to an adjacent pivot **209** of the other brake shoe by a helical tension spring **204** so as to bias the brake shoes toward respective unlocked positions. Brake linings **206** are secured to the outer arcuate sides of the brake shoes for

10 frictional engagement with the inner surface **208** of the drive head housing. One end of each brake shoe is fixed to the driven hub by means of one of the pivot pins. The other end of each shoe is free to move inwardly.

The driving and driven hubs are formed with respective grooves **210** and **212**, respectively, in adjacent surfaces **214** and **216**, for receiving drive balls **218**, of which only one is shown. The groove **210** in the driving hub is formed with a ramp or sloped surface **220** which terminates in a ball chamber **222** in which the ball is located when the drive shaft rotates in a forward direction. Centrifugal force holds the ball radially outward and upward in the ball chamber so there is no ball motion or contact with the driven hub while rotation is in the forward direction. When the shaft

15 rotates in a reverse direction, the ball moves downward to a position in which it engages and locks both hubs in position.

When the drive head starts to turn, the ball rests on the driven hub and rides up the ramp. As the speed increases, the ball jumps slightly above the ramp and is thrown up into the ball chamber, where it is held by centrifugal force.

25 When the electric motor turning the drive head is shut off, the drive head stops and the ball drops into the groove in the driven hub. The spherical surface of the driving hub wedges the ball against the spherical surface of the driven hub thus starting the brake shoes turning. The reverse ramp of the driving hub serves an important function associated with the centrifugal brake. The centrifugal brake has

30 no friction against the housing until the brake turns fast enough to overcome the brake retraction springs. If the driving hub generates impact against the driven hub during engagement, the driven hub can accelerate away from the driving hub. If the driving hub is turning fast enough, the ball will rise up into the ball chamber and stay there. By adding a reverse ramp the ball cannot rise up during impact and since the



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ramp is relatively long, it allows the driving hub to catch up to the driven hub and keep the ball down where it can wedge between the driving and driven hubs.

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**We Claim:**

1. A drive head for use with a progressive cavity pump in an oil well, comprising:  
a drive head housing;  
an input shaft rotatably mounted in said housing for connection to a drive motor;  
an annular tubular output shaft rotatably mounted in said housing and drivingly connected to said input shaft;  
a tubular standpipe concentrically mounted within output shaft in annularly spaced relation thereto defining a first tubular fluid passageway for receiving fluid at a first pressure and operable to receive a polished rod therein in annularly spaced relation defining a second tubular fluid passageway exposed to oil well pressure during normal operation  
seal means disposed in said first fluid passageway;  
means for maintaining the fluid pressure within said first fluid passageway greater than the fluid pressure in said second fluid passageway; and  
means for releasably drivingly connecting said output shaft to a polished rod mounted in said standpipe.
2. A drive head as defined in claim 1, further including a centrifugal backspin retarder coupled to said input shaft for reducing reverse rotation of said input shaft.
3. In a drive head having an upper end and a lower end, the improvement comprising a stuffing box integrated into the upper end of said drive head to enable said stuffing box to be serviced without removing said drive head from the oil well installation.
4. In a drive head as defined in claim 1, further including a fluid pump for pressurizing said stuffing box.
5. In a drive head as defined in claim 1, further including means for maintaining the uphole side of said stuffing box at a higher pressure than the downhole side thereof.



90° 180°